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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 138.

B. T. GALLOWAY, *Chief of Bureau.*

THE PRODUCTION OF CIGAR-WRAPPER TOBACCO UNDER SHADE IN THE CONNECTICUT VALLEY.

BY

J. B. STEWART,

EXPERT, TOBACCO INVESTIGATIONS.

ISSUED DECEMBER 23, 1908.

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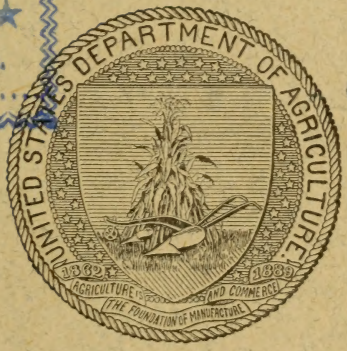

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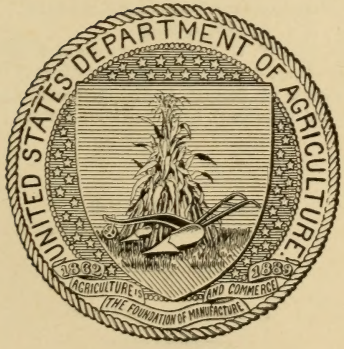

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 15, 1908.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 138 of the series of this Bureau, a manuscript entitled "The Production of Cigar-Wrapper Tobacco under Shade in the Connecticut Valley," by Mr. J. B. Stewart, of the Tobacco Investigations of this Bureau.

Respectfully,

B. T. Galloway,
Chief of Bureau

Hon. James Wilson,
Secretary of Agriculture.

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THE PRODUCTION OF CIGAR-WRAPPER TOBACCO UNDER SHADE IN THE CONNECTICUT VALLEY.

DEVELOPMENT OF THE PRODUCTION OF TOBACCO UNDER SHADE.

The method of producing tobacco under shade originated in Florida about 1896. The adoption of artificial shade was slow, and much labor and expense was incurred in experiments. In a few years, however, the tobacco produced by this method began to take its place in the trade among the higher class of goods and a demand was created for it.

It was at this time that the officials of the Connecticut Agricultural Experiment Station conferred with the representatives of the Bureau of Soils of the United States Department of Agriculture as to the advisability of conducting an experiment with the object of improving the wrapper tobacco in the Connecticut Valley by the adoption of the shade method. As a result of the agreement reached, a joint experiment was conducted in 1900, and one-third of an acre of tobacco from Florida Sumatra seed was produced under shade.

This tobacco was fermented, assorted, and packed, and when offered for sale brought 72 cents a pound. The judges who examined the tobacco, as well as the manufacturers who used it, pronounced it equal, if not superior, to the tobacco imported from the island of Sumatra. No accurate account of the expense of producing this tobacco was kept, and it could not be determined whether at the price mentioned the industry would be profitable to the growers, the object of the experiment being solely to determine whether a marketable tobacco with merit could be produced in Connecticut under shade.

At this stage of the development of the industry the cooperative agreement referred to was discontinued, the State agricultural experiment station and the Bureau of Soils continuing to work along their own lines.

In 1901 about 41 acres of tobacco were produced under shade, the Bureau of Soils furnishing experienced men to instruct the farmers in cultivating, harvesting, and shed-curing the crop, and to take

charge of the fermenting, grading, and packing of the raw product. In order to get this tobacco (about 300 bales) on the market and to secure as widespread a distribution of it as possible among the trade, it was deemed advisable to sell the entire lot by auction. Accordingly, on May 2, 1902, in the Foot Guards Hall, at Hartford, Conn., the tobacco was sold, bale by bale, to the highest bidder. The results were very satisfactory. Some of the bales sold for as much as $2.65 a pound, and one crop of 5 acres averaged for all grades $1.65 a pound, paying the grower $1,000 an acre above all expenses.

Time was not given for the purchasers of this tobacco to report on its merits. The result of the sale was accepted as bona fide evidence of the success of the new industry. The newspapers took up the cry that the salvation of the Connecticut farmer was at hand. There were to be no more hard times. Raising tobacco in Connecticut under shade was a surer road to riches than digging the yellow metal from the richest mines in the Rocky Mountains. Consequently, stock companies for growing tobacco were formed, and almost every farmer who could borrow a few thousand dollars (and borrowing was easy in the sight of such prosperity) grew shade tobacco. Men who had never been attracted by the tobacco industry now sought to purchase farms on which to produce tobacco by this new method, and seed was purchased indiscriminately in Florida at the very high price of $2 an ounce.

The shade-tobacco area spread from 41 acres in 1901 to more than 700 acres in 1902, an enormous growth for a new industry. The season of 1902 proved to be cold and wet. Many of the growers had poor varieties, and more of them did not know enough of the methods in use to enable them to produce a good quality of tobacco. The result was that almost all who had undertaken this new method of producing tobacco found themselves without money and with no market for their goods. Many of the companies and some of the farmers went into bankruptcy and sold their shade tobacco at a loss of from 75 to 90 per cent. The remainder pulled through badly crippled and, thinking that the poor quality of their tobacco was entirely due to an unfavorable season, tried to recuperate by growing shade tobacco another year. The results were, perhaps, even more unfavorable than the previous year, the industry being counted a failure and the cause of heavy financial losses.

In the year 1903 the attention of the Bureau of Plant Industry was called to the failure of shade tobacco in Connecticut, and as the Department of Agriculture had had much to do in promoting the industry it was thought necessary to do everything possible to determine the cause of the failure and apply the remedy.

Knowing the nature of plants and that when seed is transported from a warm climate to a colder one the progeny is almost sure to break up into many varieties, some desirable and some undesirable, a breaking up in type was anticipated. This was found to be the case when a plant breeder from the Bureau of Plant Industry began to make a study of the types of tobacco for uniformity. In one field of 46 acres, 29 distinctly different varieties were found and isolated.[a] Experiments with these varieties were conducted during the seasons of 1904 and 1905 to prove their merit and prepotency. Every variety came true to type, and of the 29 only 2 were found to possess any merit. This suggested a solution to the problem, which has been worked out during the last four years and has been the means of establishing upon a sound and profitable basis the shade-tobacco industry of Connecticut, as will be shown in this publication by the records of demonstration tests on a commercial basis.

CULTURE.

ERECTING THE TENT.

Too much stress can not be laid upon making the tent frame strong in every way, so that there will be as little "give" to it as possible. The outside posts should be well guyed, so that the wires will remain taut when stretched. Much trouble is often caused by the main wires, to which the cloth is sewed, becoming so loose that the pull of the cloth in the wind can move them up and down. This gives the cloth a chance to jerk and break the cord which holds it to the wire, causing a rip, which is difficult to repair.

The most economical distance to set the posts is 24 feet apart each way. To set them farther apart is not safe, because the strain upon the cloth in a high wind involves the danger of loosening the covering at a critical time.

In preparing to erect a tent the first essential is to lay off the land and place a small stake where each post is to be located. To do this start at one corner and lay off a square and set a side and end row of stakes across the field at right angles to each other, sighting them in line and measuring the distance to put them apart in the row. When this is done the rest of the field can be best laid out by the use of a triangle the sides of which are the desired length. Put one leg of the triangle against the end row of stakes and the other leg against the side row and place the new stake in the corner of the triangle. Repeat this until all of the places for posts are marked.

[a] See Bulletin No. 91 of the Bureau of Plant Industry, entitled, "Varieties of Tobacco Distributed in 1905–6, with Cultural Directions."

The digging of the holes is a simple operation and consists of removing a small portion of the topsoil with a shovel and then deepening the hole to the desired depth, which should not be less than 3 feet, by the use of a common post-hole digger. The posts should be cut at least 11½ feet long and set 3 feet in the ground, this making the tent 8½ feet high. In lining up the posts the tops should be sighted and leveled by lowering or raising a post where necessary, and the rows should be kept straight.

To guy an outside post, a timber not less than 4 feet long and 6 inches in diameter, to which is attached a No. 9 wire, should be sunk in the soil to a depth of 3 feet not less than 6 feet from the base of the post, and the other end of the wire made fast to the top of the post.

This done, the next thing is to stretch the wire. First, run the main No. 6 wires to which the cloth is to be sewed. Make one end fast to the top of an outside end post and stretch the wire taut by the use of a block and pulleys or some other powerful means of purchase and fasten it to the top of the post at the other end of the field. This wire should be fastened firmly to the top of each post in the row.

After all the main, or No. 6, wires have been put on and fastened, cross wires should be run on top of these. At the top of the cross rows of posts use No. 9 wire, and at intervals of 4 feet between the posts stretch a No. 12 wire, fastening it to the outside wire on the sides. At the crossing of two wires, they should be fastened by twisting about them a short piece of small wire. No. 16 wire is a convenient size for this purpose. At the bottom of the outside posts run a No. 9 wire for the purpose of fastening the bottom of the side-wall cloth. The frame is now complete and ready for the cloth. (See Pl. I, fig. 1.)

The cloth used for tents comes from the mills sewed into strips 24 feet wide and usually about 60 yards long. This cloth is run on the wires by threading it under one cross wire and over the next one, and where the ends of the strips meet they are sewed together. The edge of the cloth is now wound around the wire carefully and made fast by sewing with strong twine. This operation is repeated until the field is covered and the tent complete. (See Pl. I, fig. 2.)

PRODUCING THE SEEDLINGS.

Nearly every tobacco grower has his own methods of producing seedlings. In the essential points they vary but little from those of his neighbors, but the details vary considerably. It is well to mention here that if a grower is successful in producing plants by the method he now uses he had better make no change. The methods

FIG. 1.—FRAME OF TENT FOR GROWING TOBACCO UNDER SHADE.

FIG. 2.—TENT FOR GROWING TOBACCO UNDER SHADE.

recorded here are the results of several years of study among the tobacco growers of the Connecticut Valley, as well as of the writer's own practical experience.

As tobacco plants have to be grown in the early spring when the weather is cold and many raw north and west winds prevail, a site should be selected on a southern slope or the winds cut off by a hedge or a high, tight board fence. The next operation is to prepare the beds. This should be partly done in the fall by putting on organic fertilizer, such as stable manure and cotton-seed meal, and thoroughly spading it in. In the spring, as soon as the frost is out of the soil (and this can be hastened by putting a glass covering on the frames), the soil should be thoroughly spaded up and raked over and a small quantity of commercial fertilizer should be applied and raked in. The bed is now raked, leveled, and steam sterilized, when it is ready for the seed.

A great many growers sprout their seed before sowing, but in the writer's experience more healthy plants are produced in less time by sowing the seed dry. If the seed has been well cleaned and blown, about a tablespoonful to 200 square feet of seed bed is sufficient to produce a good stand of plants.

In sowing the seed never mix it with any organic substance, such as corn meal or cotton-seed meal, but use apple-tree punk and sifted coal ashes or land plaster in the following proportions: To five cups of punk add two of ashes and one tablespoonful of seed. Mix thoroughly and sow. After sowing, rake in lightly with an iron rake and press the soil firmly down with a plank. Now wet the bed thoroughly by sprinkling water on it and put on the covering, which may consist of either glass or cloth. The covering should be held about 6 inches above the soil by means of a tight frame made of inch boards placed around the bed.

The seed bed now needs much care, and if the sun is hot the covering should be raised to let in fresh air. Water should be used freely and the top of the soil kept damp until the plants are about an inch high, when water should be used more sparingly and air more frequently given.

It takes from forty to sixty days for the plants to grow large enough to be transplanted to the field. A plant should not be pulled for transplanting until it is at least 4 inches long at the stem and the stalk is almost as large in circumference as a common lead pencil. Some plants in a bed will always grow faster than others, and the large ones should always be taken out first—very carefully, so as not to injure the smaller ones, which grow to make the next pulling.

To pull the plants, first wet the bed thoroughly, so that the plant roots will pull up easily, and then pull the plants by taking hold of the

leaves, not the stem. In this way there is no danger of injuring the bud. The plants when pulled should be placed in shallow boxes, standing, roots down. In this way they can easily be carted to the field ready for transplanting.

TRANSPLANTING THE SEEDLINGS.

The transplanting of the plants is a hard ordeal for them, even at best. However, if care is taken to prepare the land thoroughly and the plants are set well in water and the weather is favorable, there will be a very small percentage of loss from dying. The cutworms and wireworms will of course destroy a few, in some seasons more than in others.

For the wireworms there is no remedy except to kill the worm when found either in the plant or about its roots. For protection against the cutworm, poison can be employed on and near the plants. Paris green and wheat middlings should be thoroughly mixed at the rate of a pound of Paris green to 140 pounds of middlings. If the mixture is stronger than this there is danger of burning the plants, and in the proportion mentioned there is enough of the poison to kill the worms. By the use of a tin can punched full of holes and fastened to a stick about 2 feet long, this mixture can be dusted over and near the plants. A jerk on the stick, shaking the can up and down, will force enough of the poison through the holes for one plant.

The plants, with the exception of the post rows, are set out with a machine called a transplanter. (See Pl. II, fig. 1.) This machine is drawn by a team which is trained to walk very slowly. The machine consists of a barrel to carry the water set on a truck, with a single wheel ahead, which acts as a roller. Behind the truck comes a plow, which opens a furrow, in which the plants are set. Following come the wings, which draw the soil over the roots of the plants and set them. The barrel of water is so connected by a rubber tube and gearing that it lets out about a cupful of water on the roots of each plant as it is set. This puts the water just where it is needed by the plants, and they thrive much better than when set by hand. A machine, three men, and a team can set from 3 to 4 acres of tobacco in a day.

The land should be thoroughly prepared for the plants by plowing, then by sowing the fertilizer, and afterwards by harrowing and smoothing. The smoothing can be done with either a smoothing harrow, a plank, or a brush, but should never be done with a land roller, as this leaves the land packed down too hard.

The fertilizer should contain the following quantities of plant food to the acre: Nitrogen, 140 pounds; phosphoric acid, 100 pounds; potash,

FIG. 1.—TRANSPLANTER AT WORK IN A TOBACCO FIELD.

FIG. 2.—HORSE HOE AT WORK IN A TOBACCO FIELD.

FIG. 1.—FIELD OF TOBACCO, SHOWING THE FIRST AND SECOND PRIMINGS REMOVED.

FIG. 2.—FIELD OF TOBACCO, SHOWING THE ARRANGEMENT OF LEAVES AFTER PRIMING.

120 pounds. On most soils about 300 pounds of lime in addition is beneficial. The heavier the texture of the soil the smaller is the quantity of potash needed.

The plants should be set in rows 3 feet apart and from 12 to 14 inches in the row. To set them farther apart than this, especially in the row, makes the tobacco grow so large and heavy that its quality is injured, although the quantity may be slightly increased.

Three or four days after the plants have been set out, the field should be looked over carefully and fresh plants set in where any have died or are missing. A perfect stand of plants is an essential requirement for a bountiful crop of tobacco of good quality.

CULTIVATING THE SOIL.

Not more than one week after the plants have been set out the soil between the rows should be cultivated with a horse cultivator and the soil around the plants loosened up with a hand hoe. If this hand hoeing is thoroughly done the operation will not necessarily have to be repeated, and further cultivation by the use of the horse hoe (see Pl. II, fig. 2) will be sufficient for the crop.

The land should be stirred as often as once a week, provided the weather conditions do not prevent it. The cultivation should be continued up to topping time, and afterwards if the tobacco has not gained sufficient size to make it impossible to go between the rows with a team without injuring the leaves.

TOPPING AND SUCKERING THE PLANTS.

As the bud appears and just before the flowers open, it should be taken off. As some of the buds will appear before others it will perhaps be necessary to go over the field several times before all of the plants are topped. After topping, the field may rest until after the first priming is made and then the four top suckers should be broken off. This gives to the second priming a body which greatly improves it. This is all of the suckering that should be done, for the taking off of more suckers or the lower topping of the plants makes the tobacco too heavy and coarse for the purpose for which it is intended.

HARVESTING THE CROP.

The time to harvest shade tobacco is when the leaves are fully developed. There is a slight change in color as the tobacco reaches maturity, but it is not safe to allow the leaves to remain on the stalk until this change of color is noticeable to the inexperienced observer, for then they are likely to be too ripe. The best method to follow, and the one which will err in the right direction, is to make the first priming about ten days after topping and the second about ten days later. (See Pl. III, fig. 1, showing a field with the second priming

removed.) The third priming may be taken off about a week after the second, and the fourth, or top-leaf priming, can follow as soon after the third as time will permit. The tobacco of this top priming is not very valuable and should it not be harvested for two or three weeks after the third priming there will not be any great loss unless there is a freeze.

By priming is meant picking the leaves from the stalk in the field. The first priming consists of taking off three or four of the bottom leaves; the second, from four to six leaves; the third, all but two leaves on top of the plant, and the fourth, the remaining leaves.

The leaves, when taken off, are laid in piles along the row. (See Pl. III, fig. 2.) A primer picks the leaves from two rows and puts his primed leaves on the row to his right. Another man priming the two rows to the right of the first primer puts his primed leaves on the row to his left. In this way, two adjoining rows contain all of the primed leaves from four rows of tobacco. A man takes a basket (see Pl. III, fig. 2) and going between these two rows picks up the primed leaves and carries them to a wagon with a special rack on which they are drawn to the shed or curing barn. Great care should be taken not to jam or press down the leaves in the basket so as to bruise them.

In the barn are laths with string attached on which the leaves are sewn with a needle. (See Pl. IV, fig. 1.) This string is fastened to the laths by means of a saw-cut about one-half inch deep in each end. The string is run through the cut, wound once about the lath, and returned through the cut. This holds the string firm. From 32 to 40 leaves, according to their size, are put on each string, face to face and back to back, and the string is fastened to the other end of the lath. These leaves when hung as described are called a "lath" of tobacco, and these laths are now hung on tier poles in the barn to cure.

CURING.

The curing is an important process, for much can be done to add to the quality of the tobacco at this time and if the weather is damp and rainy much needs to be done to prevent the tobacco from being ruined. Tobacco requires from twenty to thirty days to cure and during this period it needs constant care.

If the barns are properly built the curing is done with a certain degree of accuracy. A model barn for this purpose should not be larger than 100 by 40 feet and 20 feet to the eaves. (See Pl. V, figs. 1 and 2.) The walls of the barn should be made of ship lap siding, so that they can be tightly closed. A horizontal ventilator, 6 inches wide, should be placed every 30 inches on the sides of the barn and hung on hinges so that it can be easily opened and shut. By this arrangement, when the ventilators are open there is a circulation of air through the barn between the layers of tobacco.

FIG. 1.—INTERIOR OF A CURING SHED, SHOWING THE METHOD OF STRINGING TOBACCO.

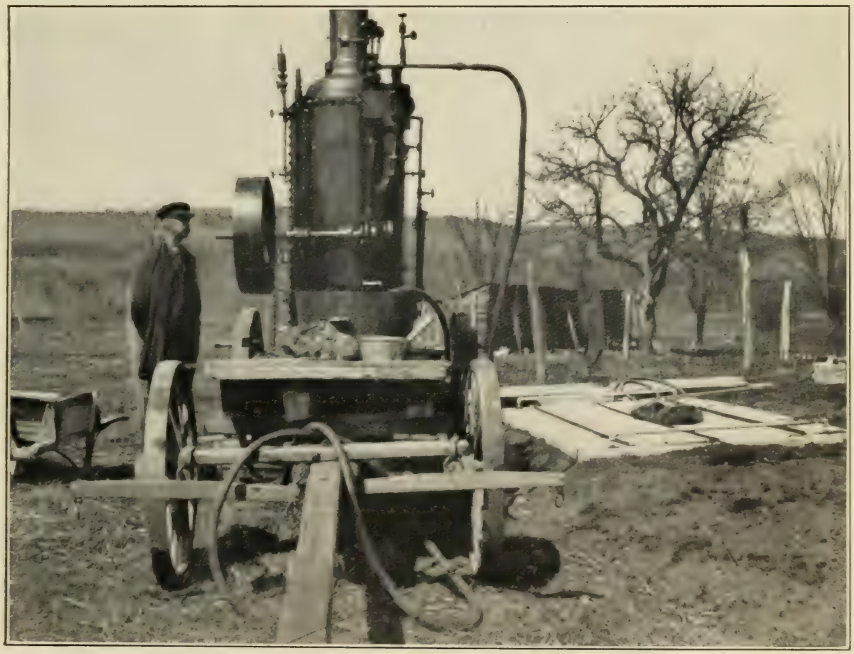

FIG. 2.—STEAM STERILIZER OF THE SOIL AT WORK.

FIG. 1.—TOBACCO BARN WITH VENTILATORS CLOSED.

FIG. 2.—TOBACCO BARN WITH VENTILATORS OPEN.

When the barn is filled with fresh tobacco it should be closed tight, and if the weather is cool or damp small charcoal fires should be built in the barn to warm up the tobacco and wilt it down. When the tobacco has wilted and started to yellow, the doors and ventilators should be opened to allow the circulation of air to carry off the moisture. If the curing season is a normal one the doors and ventilators should be opened every morning and closed at night, but if the season is dry the reverse of this action is required, especially when the process of curing the tobacco is nearly completed. If the season is a very damp and rainy one small charcoal fires, placed close together, should be lighted in the barn to dry out the tobacco and prevent it from pole sweating.

After the tobacco is cured the barn should be left closed until there comes a damp, foggy time or a rain, when all of the doors and ventilators should be opened, to allow the tobacco to come "in case," so that it can be taken down. The tobacco is in proper case for taking down when it does not rattle when handled and when at the same time if a number of leaves are squeezed tightly in the hand they will spring partly open again upon releasing the pressure.

TAKING DOWN THE LATHS.

When the tobacco is in case it is in proper condition for taking down. The floor of the barn should be cleared and some old blankets laid down. On these the tobacco is piled without removal from the laths, several laths being taken at a time and the first layer laid so that the laths will be next to the cloth and the tobacco sticking up. The next layer is piled so that the tobacco is next to the tobacco of the other layer and the laths are on top. This process is repeated until the pile is several layers high. When the pile is complete it should be covered well with either blankets or cornstalks, and it can be left with safety for several days before it is stripped if the weather is not too warm. If the weather is warm, there is danger of the tobacco heating and spoiling if left more than four or five days in the pile.

STRIPPING AND BUNDLING THE LEAVES.

The two processes of stripping and bundling go together. A lath of tobacco is taken up and the leaves shoved together at the middle of the string. The string is now severed close to each end of the lath, wound around the leaves at the butt ends, and drawn through the "hand" of leaves so as to fasten it. These "hands" of tobacco, as they are called, are packed in a false box lined with paper, butts out, and the tips of the leaves overlapping in the center. About 30 pounds are packed in each box in this way and then pressed down. Paper is wrapped about the tobacco and tied with strings which were placed at intervals along the box before the paper was put into

it. One side of the box is swung on hinges, so that it can be let down to allow the removal of the tobacco. The tobacco thus packed is called a "bundle" and is ready for market or for the packing house. When tobacco is to be packed by the grower it is not necessary to bundle it, but it may be packed at once into boxes and taken to the warehouse.

The tobacco when packed in bundles may be kept for several weeks or months without much injury if the bundles are piled one layer high and put in a cool, moist place. The sooner the tobacco is put into the ferment after it is taken down, however, the better.

PACKING.

The term "packing" in handling tobacco means the preparing of the raw product for the use of the manufacturers.

The first step in the packing of shade tobacco is to ferment it. This is done by taking the tobacco from the bundle, shaking it out thoroughly, and laying it down in layers in a large pile, called a "bulk," being careful to keep the leaves straight. To build a bulk of tobacco requires some skill and experience. If the bulk is not made properly it is liable to settle sidewise and fall over.

The bulk is built on a platform made of 1-inch boards and raised about 4 inches from the floor, so as to admit a free circulation of air. This platform is made for convenience 12 feet long by 5½ feet wide. In starting to build a bulk a row of hands of tobacco is first laid around the outside edge of the platform, being careful to keep the butts of the hands close together and the leaves straight. This is called the outside tier. The next tier of this layer is laid so as to shingle over the first, lapping well over the tips of the leaves of the first tier. This is repeated until the bottom of the platform is covered. Then another layer is laid on top of this one, and so on until the bulk is from 4 to 6 feet high.

When about half of the tobacco intended for the bulk has been laid down, a tube 4 feet long should be placed so that one end comes to the outside and the other extends to the center of the bulk. This is for the purpose of placing a thermometer in the bulk to keep a record of its temperature.

The temperature of the bulk is an index of how the tobacco is fermenting. The nature of the tobacco, its condition, the temperature of the room in which it is bulked, and the time of the year all have their influence on the degree of rapidity with which the tobacco will heat.

If the tobacco is in high case and is bulked early in the fall in a warm room, it will heat up very rapidly, and the bulk will have to be taken down, the hands of tobacco well shaken out, and the bulk rebuilt, the tobacco which has been on the outside being put on the inside and that which has been on the inside of the bulk on the outside.

On the other hand, if the tobacco is in low case, is not bulked until late in the winter, and is put down in a moderately cool room the tobacco may lay in the bulk for ten days before it begins to heat.

It is evident from these facts that the only guide in fermenting tobacco is the thermometer. The record of the thermometer, coupled with experience, can do much to improve shade tobacco during the fermenting process.

From long-continued experience in fermenting many different kinds of tobacco, the writer has come to the conclusion that the best results can be obtained by placing the tobacco in bulks of about 5,000 pounds, and when the thermometer registers 114° F. tearing down the bulk, shaking out the tobacco, and rebulking. After the bulk has been rebuilt, the temperature should be allowed to come up again to 112° F., or higher if it will, and after this the tobacco is ready for grading.

The fermentation room should be kept during the process of fermentation as nearly as possible at a temperature of 80° F., with about 75 per cent relative humidity. The temperature should be as uniform as possible, because any great change will cause the moisture in the room to settle on the butts of the tobacco and produce mold, which is likely to damage the tobacco. The room should be well ventilated by an air shaft running from near the floor of the room to above the roof of the building.

GRADING.

As shade-grown tobacco has to be graded principally according to color, a well-lighted room is required, and to avoid deep shadows and a varying light the windows should be on the north side of the room. A low ceiling is desirable so as to keep the moisture as low in the room as possible. The room should be kept so moist that the tobacco will not dry up while it is being handled.

When the tobacco is first taken from the bulk, the hands are untied and the leaves shaken out. It is then "sized" so that all of the leaves of the same length come together. This is done by a person taking the leaves and putting them into a box fixed up with partitions so that there is a space for all leaves from 12 to 14 inches long, 14 to 16 inches long, and so on.

After the tobacco has been sorted according to size it is taken to tables, where the leaves are opened and graded, all sound leaves of even color and good texture being classed as wrappers and the rest seconds or binders. The wrappers are further divided into light, medium, dark, and off or mixed, according to their color. The seconds are simply divided according to color into light and dark.

After the tobacco has been graded it is tied with raffia into hands of one-fourth pound each. These hands are now packed into bales of about 150 pounds. The common size for a bale of shade tobacco is

31 by 31 inches and 10 inches thick. The tobacco is baled by packing the hands into a false box. A piece of matting is placed on the bottom of the box and another on the top of the tobacco when the box is filled. The top is now forced down by means of a press and held there until the edges of the two pieces of matting are sewn together, when the bale is made. The bale is now given a number, the weight and grade are marked on it, and it is stored away until sold. Before it can be shipped it must be covered with burlap and crated.

MARKETING.

Tobacco is sold by means of samples, four hands being considered a sample of shade tobacco. A manufacturer or jobber when wishing to purchase shade-grown tobacco looks over a number of samples and picks out those which suit his trade. If the price is satisfactory, a sale is made and the tobacco is shipped.

SUMMARY OF METHODS OF PRODUCING SHADE TOBACCO.

The best methods of producing shade-grown tobacco may be summarized as follows:

(1) Protect the seed bed from north and west winds.

(2) Get a good strain of seed.

(3) Sterilize the seed beds.

(4) Do not sow the seed too thickly.

(5) Give the plants plenty of water.

(6) Plants will be produced under glass earlier than under cloth, but the beds will require more attention.

(7) Do not allow the plants to get too large before transplanting.

(8) Wet the beds thoroughly before pulling the plants for transplanting.

(9) Prepare the land well before transplanting.

(10) Set the plants as close as 14 inches in the row.

(11) Cultivate frequently and thoroughly.

(12) Take out the bud just before the flower opens.

(13) Sucker once, taking off four top suckers.

(14) Do not let the tobacco get too ripe before harvesting.

(15) Make four primings of the crop and keep each priming separate.

(16) Prevent pole-burn by firing, if necessary.

(17) Do not take the tobacco down until all fat stems are cured.

(18) Have the proper amount of moisture in the tobacco when it is taken down.

(19) After it is taken down do not leave the tobacco lying in bundles too long.

(20) Do not allow the temperature to go above 115° F. during fermentation.

(21) Do not ferment too long, so as to dry out the tobacco.

(22) Sort and pack the tobacco without using water to moisten it.

(23) When packed, age the tobacco in bales in a warm, moist room for six weeks.

(24) Figure the cost of production and sell at a profit.

COMMERCIAL VALUE OF SEED SELECTION.

To show the commercial value of seed selection in the production of tobacco, the results of three years' tests are given below. These results were obtained from a row test and are computed to an acre basis for convenience in making comparisons.

In 1905 and 1906 a few selections of the best varieties were grown, but in 1907 a greater number of varieties and selections were grown, many of which were taken from 1904 seed. This was done in order to secure further comparisons for commercial purposes.

In 1907 a commercial test was also made to determine the advisability of advocating the growing of shade tobacco by Connecticut farmers.

Selections having initial numbers from 1 to 10, inclusive, are Sumatra types, while those from 11 up are Cuban types of tobacco.

TABLE I.—*Comparison of selections of varieties of tobacco tested in 1905, 1906, and 1907 reduced to an acre basis.*

Year.	Selection number.	Grade.					Total yield.		Shrinkage.
		Light wrappers.	Medium wrappers.	Dark wrappers.	Seconds.	Off color.	Raw weight.	Packed weight.	
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1905	2-16- 1	269	217	101	341	.....	1,081	1,028	53
	3-20- 2	328	111	323	628	.....	1,433	1,390	43
	3-15- 1	616	308	215	198	.....	1,341	1,337	14
	13- 2- 3	235	273	351	304	.....	1,210	1,163	47
	14- 1-11	225	148	144	300	.....	882	817	65
	20-15- 1	102	191	191	162	.....	710	646	64
1906	3-15- 1	555	128	320	453	.....	1,520	1,455	65
	3-20- 2	499	100	404	321	.....	1,480	1,312	168
	13- 2- 3	333	240	397	184	.....	1,280	1,154	124
	11-14-16- 1	205	282	699	232	.....	1,538	1,418	120
	3-16- 8	523	366	576	278	.....	1,817	1,737	80
1907	11-32- 3	217	331	337	85	270	1,360	1,240	120
	11-31- 5- 3	448	271	342	92	127	1,380	1,280	100
	11-31- 5- 2	298	270	241	149	262	1,300	1,220	80
	12- 3- 7- 3	158	195	315	340	152	1,208	1,160	48
	13- 2- 3- 1	498	387	268	54	133	1,401	1,340	61
	13- 3- 7- 3	171	217	340	361	171	1,320	1,260	60
	13- 6- 2- 4	374	330	390	68	68	1,280	1,230	50
	14- 2- 7	293	336	165	61	165	1,060	1,020	40
	14- 2- 9	350	214	170	231	175	1,185	1,140	45
	14- 2-10	149	255	411	58	154	1,150	1,120	30
	14- 9- 5- 6	614	150	188	121	150	1,280	1,250	30
	20- 3- 2- 1	93	147	530	141	39	1,005	980	25
	20-16- 1- 2	223	223	267	100	77	905	890	15
	24- 7- 1	189	143	221	170	117	863	840	23
	109- 8- 3- 2	224	288	363	288	417	1,640	1,580	60
	1-15- 1	181	181	372	464	327	1,568	1,525	43
	2-12- 5- 1	815	236	132	38	199	1,520	1,420	100
	2-16- 4- 1	495	292	221	220	232	1,520	1,460	60
	3-12- 3	153	186	425	462	314	1,620	1,540	80
	3-15- 1	220	61	136	539	504	1,555	1,460	95
	3-16- 8- 6- 1- 2	176	83	237	784	200	1,565	1,480	85
	3-18- 3- 1	285	102	102	364	567	1,517	1,420	97
	3-20- 8- 4- 1	156	119	225	545	446	1,598	1,490	108
	3-20- 8- 4- 3	247	66	297	257	593	1,585	1,460	125
	3-20- 8- 5-15	419	166	236	243	416	1,622	1,480	142

The grading shown in Table I was not as thorough during 1905 and 1906 as it was in 1907. Many of the leaves of the 1905 and 1906 crops which were "off" or streaked in color were put into the light and medium grades. This was a mistake, because the mixture of these off-colored leaves with the others was seriously objected to by the cigar manufacturers, and in this way the commercial value of the tobacco was reduced. The results of the experience of these two years caused the writer to make a grade of "off color," which was used in the 1907 experiment.

In these tests it was not always true that the selection yielding the greatest number of pounds to the acre or grading the highest number of pounds of light wrappers was the most valuable for commercial purposes. In 1905, for instance, the selection No. 3–15–1, which yielded 1,341 pounds of raw tobacco per acre, from which 616 pounds of light wrappers were graded, had a fine appearance when moist, but did not contain substance enough to hold together when put on a cigar. This made it of little value for commercial purposes. Selection No. 13–2–3, which gave a yield of 1,210 pounds and sorted out only 235 pounds of light wrappers, proved to be a very valuable selection, because the quality of the tobacco was such that it could be used on a high-grade cigar with satisfaction. For this reason this selection was looked upon with favor for commercial purposes. It was tested again along with other selections in 1906 and was found to have increased in yield and grade without any deterioration in quality. The showing this selection had made for two years caused it to be chosen for a commercial test in 1907.

In 1907 a contract was entered into between the Department of Agriculture and Mr. Cyrus M. Hubbard, of Sunderland, Mass., under which 3 acres of shade tobacco were to be grown under the supervision of and from seed furnished by the Bureau of Plant Industry. To make Mr. Hubbard secure, a guaranty was given that he would receive at least $750 an acre from the sale of his tobacco. If he did not receive this amount the Department would make up the difference. Mr. Hubbard was to keep an account of all expenditures, so that the cost of production would be accurately known.

The results of Mr. Hubbard's test are as follows:

Cost of producing three acres of shade tobacco in the Connecticut Valley.

6 per cent interest on 3 acres of land valued at $300 an acre	$54.00
6 per cent interest and 5 per cent depreciation on a barn for curing tobacco, valued at $600	66.00
6 per cent interest and 10 per cent depreciation on a tent frame valued at $300	48.00
Repairs to tent frame	14.25

Cloth to cover frame	$548.93
Putting cloth on frame	23.00
Production of seedlings	52.53
Fertilizer	185.25
Applying fertilizer	4.80
Preparation of land	26.05
Transplanting	28.75
Restocking and poisoning	6.00
Cultivation of crop	30.40
Topping and suckering	17.70
Repairs to tent during season	29.76
Straightening up tobacco after storm	2.25
Remodeling shed in which to hang primed tobacco	22.50
Twine for putting on laths on which to string leaves	5.45
Stringing leaves on laths	69.65
Priming and hanging in barn	168.90
Curing and prevention of pole-sweat	25.55
Taking down, stripping, and bundling tobacco	34.50
Delivering tobacco	7.00
Removing cloth from frame	14.25
Cutting tobacco stalks and clearing field	24.50
Total cost	1,509.97

This tobacco was sold to a firm in Hartford, Conn., under the condition that the Department of Agriculture would furnish directions for sorting and packing, the buyers in return to give the Department detailed information as to the cost of packing and grading and to advise the price which was received for the tobacco. The same firm bought another small crop of shade tobacco, part of which was Cuban and part Sumatra, which was packed with the crop bought from Mr. Hubbard. The report furnished to the Bureau of Plant Industry is as follows:

Report on fermentation, grading, and selling of shade-grown tobacco from the Connecticut Valley, May 1, 1908.

COST OF TOBACCO.

Paid C. Hubbard for	4,204 pounds at $0.55		$2,312.20
Paid Indian Head Plantation Company for	1,574 pounds at	.55	865.70
Paid Indian Head Plantation Company for	733 pounds at	.35	256.55
	6,511		

OUTLAY.

Labor for sorting and baling	$742.90
Labor on bulk	44.20
Cost of mats and crates	77.00
Insurance for six months	35.00
Sundry outlays, receiving, etc	21.00
Interest on investment for six months at 6 per cent	135.63
Total	4,490.18

DETAILS OF HANDLING.

Average cost in bundles	$0.5271
Total number of pounds bought	6,511
Total number of pounds packed	5,993
Loss by shrinkage, pounds	518

or $7\frac{95}{100}$ per cent.

Cost of sorting, baling, and fermenting in bulk, 15 cents a pound.

5,993 pounds made—

1,400 pounds of light wrappers, or 23+ per cent.
1,425 pounds of medium wrappers, or 23+ per cent.
1,319 pounds of dark wrappers, or 22+ per cent.
891 pounds of seconds, or 14+ per cent.
958 pounds of tops, or 16+ per cent.

Cost of tobacco in bales, 74.92 cents a pound.

Grading of tobacco, 12, 14, 16, 18, 20, 22, and 24 inches, 2,269 pounds being 18 inches long.

The tobacco was sold at prices varying from 38 cents a pound for dark wrappers, seconds, and tops, to $1.75 and $1.85 a pound for 18-inch light wrappers.

SUMMARY.

Net proceeds of sales, 38 bales	$5,076.43
Gross amount invested	4,490.18
Net profits	586.25

From Mr. Hubbard's record of the cost of the production of shade tobacco to the grower and isolating this crop from the buyers' account of the packing and selling of all such tobacco handled, the shrinkage of this particular crop during fermentation and packing being 5.37 per cent, or 226 pounds, the following table showing the net profits to grower and packer is presented:

TABLE II.—*Cost and profits on the growing and packing of a 3-acre plot of shade tobacco in the Connecticut Valley.*

	On 3 acres.	On 1 acre.	On 1 pound.	Basis of computation.
Cost to grower	$1,509.97	$503.32	$0.36	Raw weight.
Price paid to grower	2,312.20	770.73	.55	Do.
Profit made by grower	802.23	267.41	.19	Do.
Initial cost to dealer	2,312.20	770.73	.55	Do.
Cost of packing to dealer	630.60	210.20	.15	Do.
Total cost to dealer	2,942.80	980.93	.70	Do.
Do	2,942.80	980.93	.74	Packed weight.
Price paid to dealer	3,282.86	1,094.29	.82	Do.
Profit to dealer	340.06	113.36	.08	Do.
Total profit made	1,142.29	380.77	.27	Do.

The profits made in growing and handling this lot of shade tobacco would have been greater had it not been for the financial depression and for the fact that so small a quantity can not be handled and marketed to the best advantage.

That the tobacco has merit and will win for itself a place in the market is shown by the following statement from the buyers, located at Hartford, Conn.:

Inclosed herewith please find our report on account sales of the Cuban shade-grown tobacco purchased through your Department last October, in which you will find all of the details and outlays; also the net proceeds which we have received on the amount of tobacco which has been sold.

We are of the opinion that the experiment has been a success on account of now having actual data to base further experiments on. The prices obtained for the various grades of this tobacco have been, in our opinion, their true value; there is, however, no doubt that if the cigar trade had been in a normal condition the entire lot would have been sold some time ago. This tobacco has been sold to cigar manufacturers and leaf-tobacco dealers in various parts of the country, and of the entire number of bales seven were sold direct to cigar manufacturers and the balance to leaf dealers. In each case the first order was for a single bale only, and in every instance we have received duplicate orders, which is the best evidence that the tobacco has merit.

We are of the opinion that this tobacco can be grown profitably in this section and that a demand can be created for same. It being a distinctive type of leaf, it can not be used successfully as a substitute for Sumatra or Connecticut Havana seed, but should be sold and used for what it is. The yield and burning qualities are excellent and the size and shape of the leaf are such as the cigar manufacturers consider profitable.

In regard to the culture and care of this tobacco, too much stress can not be laid on the importance of allowing the tobacco to properly ripen; also, in taking the crop from the curing shed with a sufficient amount of moisture, as the success of bulk-sweating shade-grown tobacco depends largely on the condition of the same when it is placed in the bulk. It should be such that no water would be necessary, either while the tobacco is in the bulk or when it is assorted, and none has been used on the crop which we have handled.

The cost of handling can be reduced by having a larger quantity, but with this small amount it required extra time to look after small details, which has increased the cost of assorting.

We believe that the growers of the Connecticut Valley can grow shade-grown tobacco of the Cuban variety at a profit, but they should commence by growing a few acres only and gradually increase up to 10 acres, which is ample for any one grower to care for.

The following report from the growers shows the initial cost of preparing a small field at Tariffville, Conn., for the growing of shade tobacco, together with the expense of producing the first crop, including that part of the expense of building the frame which should be charged to this crop. This report also shows that it is not practicable to pack such a small crop, because the bales of tobacco are too much broken up to sell to the best advantage.

Report of Cuban-seed tobacco grown on 303 square rods under cloth in the Connecticut Valley.

COST OF LABOR.

Setting posts	$20.66
Erecting wire	10.34
Plowing and preparing ground	6.50
Mixing and sowing fertilizer	7.04

Erecting cloth	$49.67
Taking up and resetting plants	24.64
Hoeing	20.58
Suckering	8.50
Stringing laths	9.73
Topping	2.53
Harvesting	170.68
Pulling stalks	5.22
Stripping	26.74
Miscellaneous	5.83
Superintendence	45.00
Total	423.66

SUMMARY OF COST OF PRODUCTION.

Labor	$423.66
Wire	33.78
Cloth	372.00
Posts	35.00
Fertilizer ($27.60 and $35, barnyard manure; $60, meal)	122.60
Interest on plant and $\frac{1}{2}\frac{1}{0}$ depreciation	66.00
Cuban plants	22.00
Total	1,075.04

CREDITS TO COST ACCOUNT.

One-half cost of cloth	$186.00
Four-fifths cost of poles and setting	44.53
Four-fifths cost of wire and wiring	35.30
Total	265.83

Debits	1,075.04
Credits	265.83
Net cost of production	809.21

Weight of green tobacco in bundles, 2,380 pounds.

The growers refused an offer of 60 cents a pound for their tobacco in the bundle. At this price they would have made clear profits as follows:

On entire field of 303 square rods, producing 2,380 pounds, the gross receipts at 60 cents are	$1,428.00
Cost of production, as per report	809.21
Net profit	618.79
Net profit on 1 acre	326.73
Net profit per pound	.2593

Figuring from another standpoint, the growers would have received over and above all expenses of erecting the frame, producing the crop, etc., a net profit of $352.96 on 303 square rods, or a net profit per acre of $186.38.

From the foregoing data collected from the growing of commercial crops of shade-grown tobacco, the writer does not hesitate to state that any farmer who has suitable tobacco land in the Connecticut Valley can produce this tobacco at a profit, provided he will give it careful attention and handle it so that the leaves will be sound and of good quality.

EFFECT ON TOBACCO OF SIZE OF MESH IN CLOTH USED FOR SHADE.

For the purpose of determining the effect of the size of the mesh in the cloth used for shade on the yield and quality of the tobacco, two selections were planted in 1906 and the rows part way across the field were covered with a cloth having 12 threads to the inch, while the other part of the rows was covered with a cloth having only 8 threads to the inch. The tobacco from each section was harvested, cured, and graded separately. The result is given in Table III:

TABLE III.—*Comparison of the effect of the size of the mesh in cloth used for shade on tobacco in the Connecticut Valley.*

Selection.	Number of threads to inch.	Grade.				Total.
		Light wrappers.	Medium wrappers.	Dark wrappers.	Seconds.	
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
3-15-1	12	555	128	320	453	1,455
3-15-1	8	464	203	351	328	1,346
13- 2-3	12	333	240	397	184	1,144
13- 2-3	8	212	182	399	142	935

From these records the only conclusion to be made is that cloth containing 12 threads to the inch produces a higher yield and a better quality of tobacco than that which contains only 8 threads to the inch.

THE IMPROVEMENT OF TOBACCO OBTAINED BY SEED SELECTION.

The methods used in selecting tobacco seed to improve the commercial crop have been thoroughly explained in Bulletin No. 91 of the Bureau of Plant Industry[a]. It is the writer's intention here simply to emphasize the fact that tobacco can be greatly improved by seed selection, both as to yield and quality, by giving some data which have been collected in connection with the other experiments. From the data referred to, the records of Type 13 selections are presented in Table IV.

[a] Shamel, A. D., and Cobey, W. W. Varieties of Tobacco Seed Distributed in 1905–6, with Cultural Directions. 1906.

TABLE IV.—*Record of three years' breeding in Type 13–2–3.*

Year.	Selection.	Wrappers.	Seconds.	Total. yield.
		Pounds.	*Pounds.*	*Pounds.*
1905	13–2–3	859	304	1,163
1906	13–2–3	970	184	1,154
1907	13–2–3	1,153	187	1,340

Table IV shows that for the three years specified the number of pounds of wrappers was increased and that the seed plants selected in 1906 gave a substantial increase in yield and quality over the 1906 crop.

THE STERILIZING OF SEED BEDS.

The sterilizing of seed beds is a new and very important feature in the production of tobacco seedlings. This practice was brought about by the general prevalence of a disease known as *Thielavia basicola*, which attacked the roots of the young plants and completely destroyed them. This disease made its appearance in 1905 and seemed to spring up spontaneously in several sections of the Connecticut Valley. It was of so serious a nature that experiments were made at once with a view to checking its growth.

In the spring of 1907 the writer conducted a series of experiments on a very badly diseased bed. Sections of the bed were sterilized with steam; with formalin, 1 to 200 parts of water, applied at the rate of 1 gallon to the square foot of seed bed, and with surface fire.

The steam sterilization proved to give the best satisfaction, this method[a] not only killing the fungi, but destroying all weed seeds. The results were so satisfactory that this practice was recommended to the farmers, and a number of them used it in the season of 1908 with excellent results.

The beds are sterilized after they have been prepared for the seed and just before the seed is sown. A galvanized pan 10 by 6 feet and 6 inches deep (see Pl. IV, fig. 2) is inverted and the edges are pushed down into the soil 1 or 2 inches. The pan is connected with a steam boiler by means of a steam hose, and live steam is run into the pan for about forty minutes under a pressure of from 100 pounds up. The higher the pressure the more thoroughly the soil will be sterilized.

To get the results and ascertain the effectiveness of steam sterilization of seed beds, the following circular was sent out on June 17, 1908, to all growers who sterilized their beds:

In order that we may get an idea of the value of steam sterilizing of seed beds for the production of tobacco plants, will you kindly answer the following questions and return this sheet in the inclosed envelope?

[a] Devised by Mr. A. D. Shamel, of the Bureau of Plant Industry.

How many years have you sterilized?
How many square feet of seed bed did you sterilize?
How many minutes did you sterilize each section?
Did you have any weeds on your sterilized bed?
Did the plants do as well on the sterilized bed as they did on the unsterilized beds?
Were the plants as hardy on the sterilized beds?
Did the beds require more water when sterilized?
How much did it cost you to sterilize your beds?
How much did you gain by sterilizing?
Do you wish to sterilize next year?
Do you consider steam sterilizing of seed beds practicable and profitable?
Give below any other information you can relative to the effectiveness or advantages of steam sterilizing of tobacco beds.

In reply to this circular of inquiry the data given in Table V were received.

TABLE V.—*Area of tobacco seed beds sterilized and results of such sterilization.*

Name.	Address.	Square feet sterilized.	Cost of sterilizing.	Gain by sterilizing.	Remarks.
M. Barns	Southwick, Mass	750	$4.80	$15.00	Grew faster.
W. Griffin	do	600	5.00	5.00	Grew faster.
L. Wetherby	do	720	4.25	20.00	Plants earlier.
A. H. Coe	do	300	2.00	15.00	Plants earlier.
F. B. Griffin	Bloomfield, Conn	4,000	30.00	40.00	Plants earlier.
Total		6,370	46.05	95.00	

It will be noted that the cost of sterilizing 6,370 square feet was $46.05, or 0.72 cent per square foot, while the financial gain over and above the cost was $95, or 1.5 cents per square foot. In every case the plants from the sterilized beds did better, grew faster, and were more healthy than those from unsterilized beds, and in consequence all the farmers named in Table V intend to sterilize again next year.

The results obtained from the steam sterilization of the soil make it safe to recommend to every farmer that he employ this method upon his tobacco seed beds.

CONCLUSIONS.

From the results of actual experiments it is evident that tobacco can be produced profitably in the Connecticut Valley under shade, provided the grower will obtain a good strain of seed and start in on a small scale until he gets some experience in growing and handling the crop.

The best cloth to use for shade is one with twelve hard twisted threads to the inch.

In order to insure an abundance of good healthy plants the seed beds should be sterilized.

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